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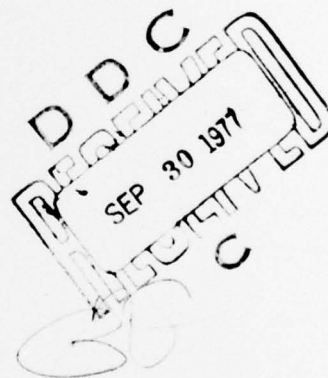
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DISADVANTAGES AND ADVANTAGES OF SEWAGE DISPOSAL IN CONNECTION WITH AGRICULTURAL UTILIZATION

J. Wierzbicki



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COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
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DISADVANTAGES AND ADVANTAGES OF SEWAGE DISPOSAL IN CONNECTION WITH
AGRICULTURAL UTILIZATION

(Wady i zalety oczyszczania wód ściekowych w połączeniu z ich rolniczym
wykorzystaniem)

Jan Wierzbicki, Dr. Eng.

(Report given at the 26th Congress of Polish Gas-Fitters, Plumbers and
Sanitary Technicians in Lodz, July 1949)

One should think that the purification of sewage with simultaneous agricultural utilization should be preferred to other means of neutralization because of the very high degree of purification obtained and the benefits resulting from a considerable increase in agricultural production.

A number of negative factors in the agricultural use of sewage oppose the general application of this method, and the purpose of this report is to present as objectively as possible all of the pros and cons on the basis of specific examples of sewage disposal in connection with agricultural utilization. Since it happened in 1559, Bolesławiec¹ (in lower Silesia) was the first city in Europe to break with the tradition of discharging city sewage into rivers, and instead of polluting the small Bobrawe River (average flow rate about 8 m³/sec), used this water to irrigate 15 ha of meadow along the river. The notes in the town chronicles and the constant leasing and sales contracts, which confirm the unusually high estimate of the value of the irrigated parcels in comparison with the nonirrigated ones, proved that these results were good. It should be stressed that in the XIX and XX Centuries Bolesławiec was renowned as one of the most healthful cities in Central Europe.

The second half of the XIX Century saw a rapid development of devices to purify sewage in connection with agricultural utilization. A couple of hundred towns constructed irrigation fields which assured a high degree of sewage purification, and at the same time offered benefits through the increased yield of agricultural lands.

The rapid development of cities and the difficulty of increasing the area of irrigation fields (high cost, lack of suitable terrain) led to overburdening of the fields² and then to unsatisfactory purification and poor crops. In 1906 agricultural circles in Germany came out against the use of sewage for agricultural purposes, citing inconveniences with transportation and distribution, and relatively high costs in comparison with the use of artificial fertilizers. Actually a number of cities with irrigated fields which were not overloaded could have served as a model of good sewage disposal and possibilities of plentiful harvests (including Legnica³ and Wrocław⁴), but for a rather long

¹Wierzbicki, J. "Bolesławiec, the Oldest City in Europe Using Sewage Water to Irrigate Pasture Land", Gaz, Woda i Technika Sanitarna, No. 9, 1948.

²Skibniewski, L. "Agricultural Use of Urban and Industrial Sewage", Gaz, Woda i Technika Sanitarna, Nos. 3 and 4, 1946.

³Wierzbicki, J. "Irrigated Fields in the City of Legnica", Gaz, Woda i Technika Sanitarna, No. 11, 1948.

⁴Wierzbicki, J. "Purification of Sewage Water in the City of Wrocław", Gospodarka Wodna, No. 2, 1947.

period of time irrigated fields were considered an outdated method, replaced under the influence of technology by a new system based on artificial biological purification. During this period (1905 - 1930) the number of new fields established and irrigated by urban sewage water was not large, and only in the last decade before World War II did a turn in the direction of propagating the agricultural utilization of sewage occur.

The defects that can be attributed to this method of purifying sewage in connection with agricultural utilization are quite numerous.

In particular such purification requires very large areas. If arable land is to be designated for irrigation, since 1 ha can be covered with the sewage from 30 - 60 inhabitants, the necessary area for a city of one-half million requires about 10,000 ha. With pasture lands (meadows and pastures) predominating, this surface can be reduced by one-half. The majority of cities use a great deal larger load, for example Paris, which disposes 600,000 m³ of sewage (with a total daily average of 950,000 m³ in 1937), fills one ha with the sewage from about 700 inhabitants, with the mean height of annual irrigation amounting to about 4200 mm (1).

The next fault with irrigated fields is the need to have suitable terrain available (desirable permeable ground) at a distance from the city because of the plague of flies and the noxious odors in the environment. If the city water plan makes use of ground water, the irrigated fields must be located in the opposite direction, downstream. The distance of the fields from the city cannot be very long, because pumping costs add a great deal to the cost of operation. Possibilities for removing sewage from major cities are quite limited. Berlin, which has 10,708 ha of irrigated fields with a total area of 25,255 ha of land designated for the agricultural utilization of sewage, cannot continue to increase this area, since there is a lack of suitable terrain in the vicinity, while pumping over longer distances would not be profitable because of the accompanying high costs.

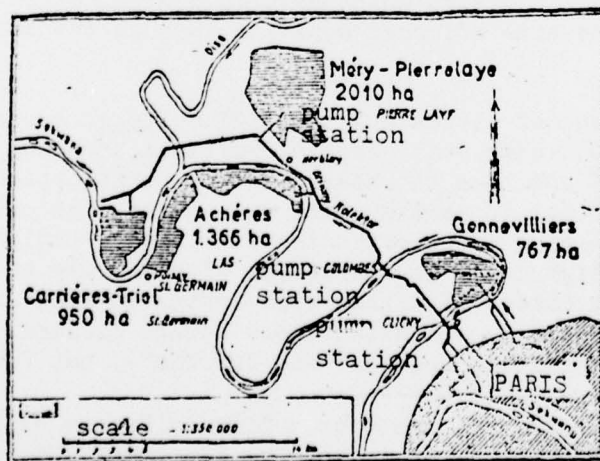


Figure 1. The irrigated fields of the city of Paris.

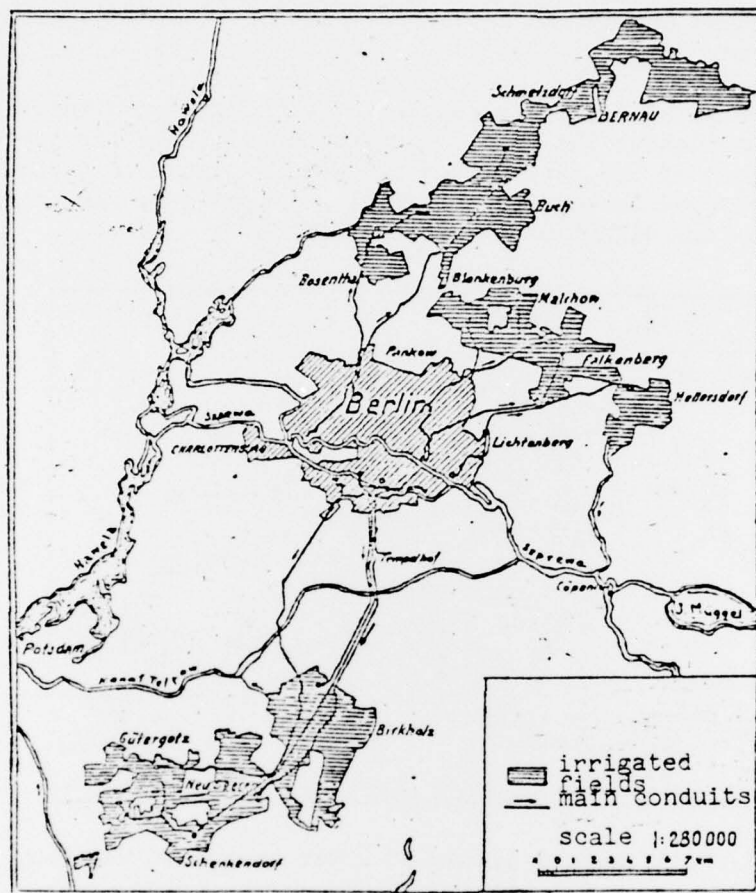


Figure 2. Irrigated fields in Berlin.

The current length of the pumping circuits is 30 km (Berlin-Schenkendorf), and a greater distance is considered as limiting under these conditions.

A considerable number of agricultural crops on irrigated fields produce poor or unsatisfactory harvest, especially when the amount of sewage is too great. Only green areas, and particularly grass, absorb irrigation which is even excessive for other crops well (e.g., root and grain crops), and produce good harvests.

The excessive growth of weeds (wheat-grass, Anthemis, nettles, etc.) on the irrigated fields and the need for constant control of weeds, even on the irrigated meadows, are a serious drawback in these fields.

Irrigating fields requires the work of a relatively large number of workers in comparison with the service of a purification plant based on the artificial

biological method. E.g., the average size of the Bydgoszcz fields (201 ha) required⁵ the constant employment and supervision of 10 persons with seasonal hiring of more labor.

The use of irrigated fields is associated with many problems: the sewage must be accepted throughout the year, which is not suitable for agricultural purposes. The wishes of the Agricultural Office in regard to irrigated fields do not always correspond to the technological requirements, resulting in frequent misunderstandings with the city sewage office.

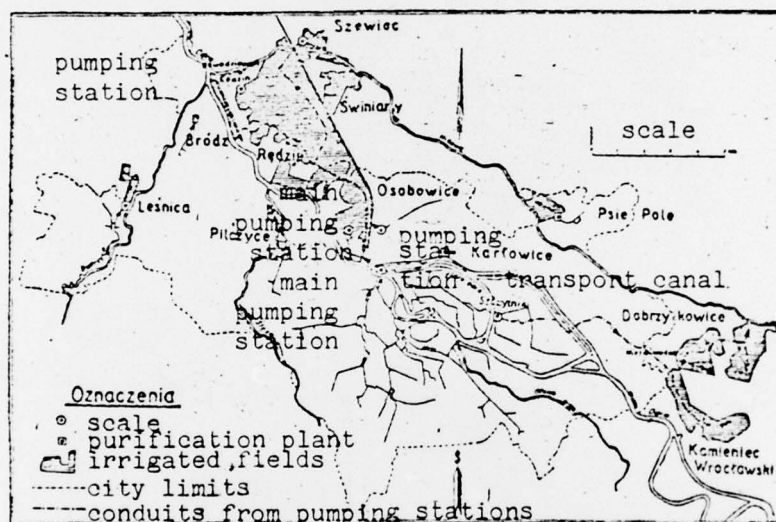


Figure 3. Purification system of urban sewage in Wrocław.

If the virtues of irrigated fields are compared with the above-mentioned faults, the virtues have the advantage.

The requirement of large surfaces for irrigation is advantageous for the social economy.

The agricultural utilization of sewage from our cities would make it possible to supply several hundred thousands of hectares of dry land with water, to provide them with the most valuable fertilizer compounds (N, K₂O and P₂O₅), and have a favorable effect on the build-up of humus in the soil, a basic condition for soil fertility.

Irrigated fields can also be located on ground which is not so permeable, under the condition of adjusting the irrigation to the needs of plant life.

Only very large cities located on lowlands (e.g., Berlin) can have difficulty in disposing of sewage in irrigation fields. Other cities can dispose of their sewage in areas several kilometers away from the city by gravity flow

⁵Data 20 years old.

or by pumping to a slight height.

In Wroclaw, for example, the pumping height for the main fields is only 7 m for conduits 1.5 km long. Then the water begins to flow by gravity.

The area of the green lands on the fields of the city of Wroclaw amounts to about 65%. Fields established in more modern times have comparatively more pasture lands (meadow and pasture): 90 - 95%. Such a high percentage of green lands is justified by the good profitability of their crops. From the economic standpoint this constitutes the fundamental virtue of irrigated fields.

The frequent mowing of meadows or pastures leads to a decrease in weeds, because only grass can tolerate multiple harvesting (4 - 5 times).

Just how profitable the use of sewage water for irrigating meadows is, is proven by the example of the water of the Ner (River), which is completely polluted by the sewage from the city of Lodz.

The irrigation devices (the ditch flow system of the ridge flow system) were used on meadows running along both banks of the river for a distance of about 40 km and covering a surface of about 15 m² (1), generally obtaining very good results: thanks to irrigation the hay harvest increased from several quintals per ha to scores, and often reaches 100 quintals per ha.

Sometimes irrigation systems (set up voluntarily by farmers) and adaptive work has been done with a relatively large outlay of labor and costs: e.g., moving the sewage 5 km from the Ner River to irrigate the meadows of the village of Pudlowek-Zernik, located in the valley of the Pisa River required a complete change in the configuration of the terrain over an area of 8 ha in order to make it possible to irrigate the former semi-wasteland in the village of Pudlow, etc. Soon the work begun just before World War II will be continued for the purpose of irrigating about 5,000 ha of deep, barren sands in the village of Rud, which is wasteland to a large extent, and which grows even pines and birches poorly.

If the urban sewage had been purified by using the artificial biological method, the Ner would have pure water, while the harvest from the meadows along the Ner would certainly be a great deal smaller.

If a city provides its sewage to irrigation company land on the basis of a contract, the city bears the cost of pumping the water to the company land. The company accepts this water and distributes it by its own efforts to the property of individual partners. This eases the job of the Agricultural Administration.

The largest company of this type was established in 1933 for the agricultural utilization of sewage from the city of Leipzig; 20,000 ha (200 km²) of company lands received a daily average of 60,000 m³ of sewage.

The municipal pumping station pumps the water to the fields through a 13 km pipe to a pumping height of 38 m. Afterward the sewage is the

responsibility of the company. A 500 km network of trenches cuts across the irrigated area. Ravines and depressions in the land are crossed with pipes of an average 200 - 1200 mm length. The total pipe length is 40 km. Various methods of irrigation are used on the company land: slope (for pastures), trench, flow (from pipes) and spraying. Arable lands are irrigated (especially in Winter) every couple of years, thanks to which the fear of excess fertilization is removed. Pasture lands are mainly irrigated in the Summer: green areas benefit most by spraying with sewage.

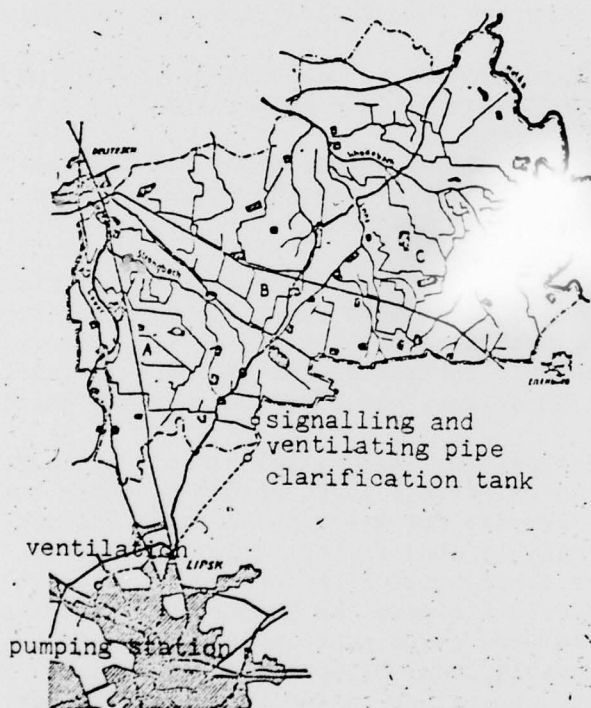


Figure 4. Map of the "Delitzsch" Water Company using sewage from Leipzig.

Practice and utilization (1937, 1938) have shown that the company cannot always use the water sent to the fields by the company: during harvests, long periods of rain and frosts, the agricultural utilization of sewage must be limited or stopped because the partners are occupied in harvesting work, because of excessive moisture in the soil, or the impossibility of irrigating. In this period of 1/3 - 1/6 of the year, depending on the climate, sewage should be purified in some other way (e.g., or if possible, sand in waste land or forest areas can be irrigated⁶).

⁶ E. Kirwald discusses this method of using sewage with simultaneous purification in Forstliche Wasserhaushalttechnik (Forest Water Economy Technology), Neudamm, (Berlin), 1944.

Although the purification of sewage in connection with agricultural use has certain disadvantages that the author has mentioned in this report, the possibility of obtaining very significant economic advantages dictates in favor of the widest possible application of this kind of sewage purification⁷.

⁷Wierzbici, J. "A Problem of Utilizing Urban Industrial Sewage to Improve Land in Poland", Gaz, Wodi i Technika Sanitarna, No. 5, 1948.